Jl S. Afr. Bot. 43 (4): 243–261 (1977)

HABITAT OF RESTIONACEAE ENDEMIC TO THE SOUTH-WESTERN CAPE COASTAL FLATS

A. V. Milewski*

(Rare and Endangered Plant Species Research Group, Bolus Herbarium, University of Cape Town)

Abstract

The habitats of seven species of Restionaceae (genera *Elegia, Restio* and *Thamnochortus)* endemic to the coastal flats of the south-western Cape are described and compared. The species, all associated with Coastal Fynbos, have different habitats, distinguished mainly by soil type (e.g. sand, sandstone, limestone) and drainage. Habitat differences between congeners are numerically assessed using associated plants (Restionaceae and Proteaceae) as an expression of environment.

Uittreksel

HABITAT VAN RESTIONACEAE ENDEMIES OP DIE SUID-WESTELIKE KAAPSE KUSVLAKTES

Die habitat van sewe endemiese spesies van Restionaceae (genera *Elegia, Restio* en *Thamnochortus)* wat beperkte verspreidings op die kusvlakte van Suidwes-Kaapland het, word beskryf en met mekaar vergelyk. Die spesies groei almal in kusfynbos maar hulle het verskillende habitatte, hoofsaaklik op grond van bodemtipe onderskei (bv. sand, sandsteen, kalksteen) en dreineringstoestande. Habitatverskille tussen spesies in dieselfde genus word numeries bereken deur geassosieerde plantsoorte (Restionaceae en Proteaceae) as weerspieëling van omgewingstoestande te gebruik.

Introduction

Twenty-three species of Restionaceae with restricted natural ranges in the south-western Cape are regarded as threatened with extinction owing to man-made environmental changes (Rare and Endangered Species Research Group, unpublished). Information on the distribution and habitat of these species is an urgent prerequisite for their conservation. Ten species of Restionaceae are endemic to what appears to be the most critically altered environment in the south-western Cape, the coastal flats.

The habitats of species of Restionaceae endemic to the western coastal flats were described in a previous paper (Milewski & Esterhuysen, 1977). This study was similar to the previous study but compared in a more general way the habitats of species of wider occurrence, those endemic to an area embracing both western

---

*Present address: School of Environmental and Life Sciences, Murdoch University, Murdoch, Western Australia.

Accepted for publication 18th March, 1977.

and southern coastal flats. This area was arbitrarily defined here as (i) western flats as defined by Milewski and Esterhuysen (1977), but excluding the intermontane Breërivier valley, and (ii) southern flats from Cape Hangklip eastwards, south of the Riviersonderend mountain chain and the Breede River, to Cape Infanta, between sea level and 600 m altitude.

The aim of this study was to describe and interrelate the habitats of seven species of Restionaceae endemic to the coastal flats of the south-western Cape, basing comparisons mainly on a qualitative floristic method used by Milewski and Esterhuysen (1977). The study species were:

(i) *Elegia fenestrata* Pillans,
(ii) *Elegia prominens* Pillans,
(iii) *Elegia verreauxii* Mast.,
(iv) *Restio sabulosus* Pillans,
(v) *Restio dodii* Pillans,
(vi) *Thamnochortus fraternus* Pillans, and
(vii) *Thamnochortus pellucidus* Pillans.

Several other species of Restionaceae have distributions centred on, but not restricted to, the coastal flats as defined here. *Thamnochortus spicigerus* (Thunb.) R.Br., *Chondropetalum microcarpum* (Kunth) Pillans and *Restio eleocharis* Nees ex Mast. have relatively wide ranges along the south-western Cape coast, occurring on littoral and ''inland'' dunes (Weimarck, 1941; Taylor, 1969, 1972; Boucher & Jarman, 1977). *Chondropetalum rectum* (Mast.) Pillans and *Hypodiscus paludosus* Pillans occur throughout the coastal flats on clay-rich substrates, extending into intermontane flats near Wolseley and Villiersdorp. *Thamnochortus pluristachyus* Mast., poorly documented, occurs in the Bredasdorp-Riversdale area. *Staberoha multispicula* Pillans appears restricted to an area between Hermanus and Cape Agulhas but was omitted from this study owing to identification problems and the possibility that it may be conspecific with *S. cernua* (L.f.) Dur. & Schinz.

The seven study species are all leafless perennials. *Elegia fenestrata*, *Thamnochortus fraternus* and *T. pellucidus* grow as tussocks, respectively 1,5–1,8 m, 0,4–0,6 m and 0,3–0,5 m high, of unbranched stems; *T. fraternus* and *T. pellucidus* arise from a simple base and *E. fenestrata* arises from a rhizomatous base. *Elegia verreauxii* and *Restio sabulosus* form spreading mat-like stands of sparingly branched upright 0,3–0,4 m stems arising from a subterranean base of interwoven rhizomes. *Restio dodii* grows as 0,6–0,8 m tufts of branched stems arising from a simple base. *Elegia prominens* is intermediate in growth form between *E. verreauxii* and *R. dodii*, forming mat-like stands of sprawling branched stems 0,2–0,3 m high, or (in the northern parts of the species' range) more robust tufts 0,4–0,6 m high.

METHODS

All distribution records for the seven study species were obtained from the literature, Cape herbarium material and unpublished records of the Rare and Endangered Species Research Group. Two to five arbitrarily selected sample populations, scattered through the known distribution of each species, were visited, "populations" of a species being defined (Milewski & Esterhuysen, 1977) as stands farther than 2 km apart. Three populations of each species other than *Restio sabulosus* (two populations) and *Elegia prominens* (five populations) were investigated.

The physiognomy of associated vegetation, site topography and altitude, and a qualitative description of soil were recorded on site for populations of each study species. Average annual precipitation, geology and existing vegetation classifications were also recorded, using the best maps available.

Indirect (floristic) information was mainly used in comparing the habitats of the study species, which are grass-like perennials growing as a scattered sward of small tussocks or as dense mat-like colonies of interconnected plants. All members of the Restionaceae and Proteaceae growing within 0,25 m of plants of each study species were recorded, data thereby being collected only within the edaphic environment of the study species. This search for associates was continued until all study plants, or a minimum of 22 study plants scattered throughout the population, had been investigated in each population. Data on associates were thus collected from the vicinity of a total of 120–225 plants of each study species (fewest for *Restio sabulosus*, most for *Elegia prominens*). Lists, according to presence or absence, of Restionaceous associate species for each population were combined to show the "between-population frequency" (Milewski & Esterhuysen, 1977) of each associate for each study species. Lists of Proteaceous associates were combined to show the collective presence or absence of associates for each study species. Examples of associates in other families were recorded where possible.

RESULTS AND DISCUSSION

1. *General*

Figures 1 and 2 show that the study species had very restricted ranges on the coastal flats, *Elegia prominens, E. verreauxii* and *Thamnochortus fraternus* being the most widespread. All seven species were shown here to occur more widely than previously believed (Weimarck, 1941). The distributions of all the study species were discontinuous. This probably reflects the still incomplete distributional record, as well as real disjunctions owing to the patchy occurrence of various types of environment.

Table 1 gives miscellaneous information relevant to the habitats of the study species. Tables 2 and 3 show sets of associates, respectively for Restionaceae and

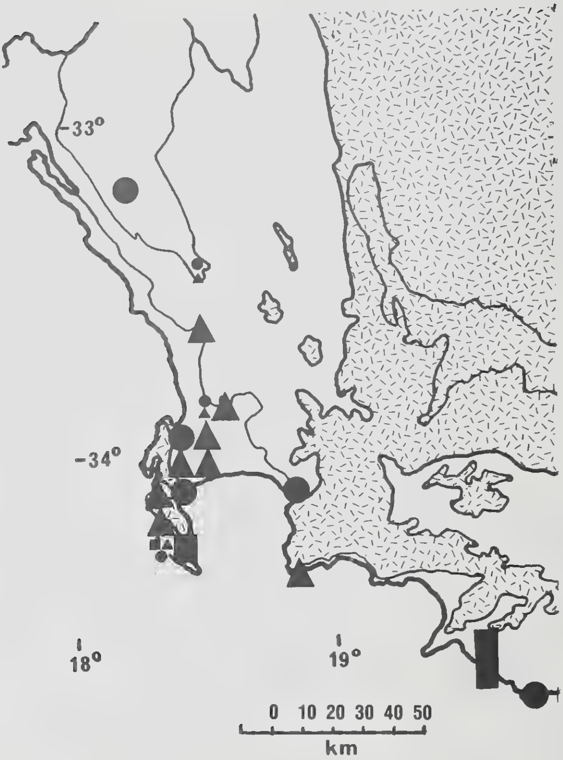

FIG. 1.*

The south-western Cape, modified after Acocks (1975) and Milewski and Esterhuysen (1977), showing distribution of *Elegia fenestrata* (■), *E. prominens* (▲), and *E. verreauxii* (●) in relation to biotic areas. Localities were plotted using a twelfth-degree grid, each symbol representing the presence of the species within a square covering one-ninth of the area of a quarter-degree grid-square (smaller versions of the symbols were used where two or more species were recorded in the same grid-square). Stippled areas are mountains largely of Table Mountain Sandstone covered mainly by Mountain Fynbos (Acocks' *Macchia*); enclosed area within this is a major intermontane valley. Clear areas are part of the coastal flats as defined, collectively comprising "sandveld", "swartland" and "voorberg" (western flats), and "ruêns" (southern flats) areas distinguished by Milewski and Esterhuysen (1977). The "Coastal Fynbos biotope" is found mainly in the delineated western part ("sandveld") of the western flats, and in the southern part of the southern flats.

**Elegia fenestrata* appears also to be recorded from S 34° 01′ E 24° 36′ (*Fourcade 2184*, from "bed of Rooipunt River," cited as *Elegia thyrsifera* Pers. by Pillans in 1928.)

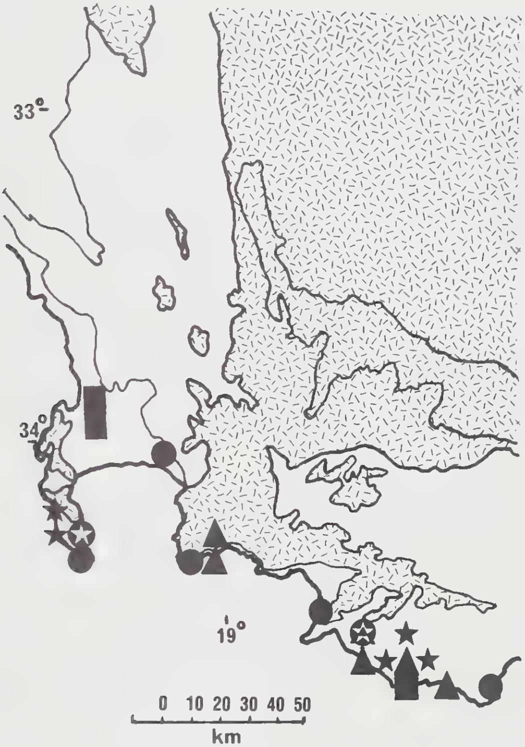

Fig. 2.

The south-western Cape as in Figure 1, showing distribution of *Restio sabulosus* (■), *R. dodii* (★), *Thamnochortus fraternus* (●) and *T. pellucidus* (▲). The symbols and indicate respectively that *R. dodii* and *T. fraternus*, and *R. dodii*, *T. fraternus* and *T. pellucidus*, were recorded in the same grid-square.

Proteaceae. The column sequence in the tables interrelates the study species on the basis of associates shared, owing to the arrangement of rows and columns.

2. *Elegia fenestrata* Pillans

Elegia fenestrata (Fig. 1) was confined to perennially moist or waterlogged sites along gently sloping drainage lines, on transported sand of Tertiary* and probably also Table Mountain Sandstone origin. It occurred near Cape Point on the littoral foreland within 200 m of the sea and on sand extending inland along a depression on a Table Mountain Sandstone plateau; populations near Quoin Point lined the phreatic zones of a number of coastal shelf streams at the base of steep limestone hills.

---

*to Recent

The vegetation associated with, and usually dominated by, *E. fenestrata* was a mainly graminoid (*sensu* Taylor, in press) Coastal Fynbos, 1–3 m high. Species recorded with two or more populations included *Schoenus nigricans, Juncus kraussii, Rhus laevigata, Leucadendron coniferum, Metalasia muricata, Helichrysum serpyllifolium* and several members of the Restionaceae (Table 2). The set of plant species collectively associated with *E. fenestrata* had much in common (Appendix 1) with lists representing communities on soil of pH 7,0–7,5 and seasonally waterlogged depressions on marine-derived sand (including shallow sand overlying limestone) on the Cape Peninsula and False Bay coast. Associates also included several species listed from communities on better-drained sandy flats, lower (''Fernwood'') dune slopes and surface limestone (pH 6,7–7,5), and others from seepage fynbos communities (Appendix 1).

3. *Elegia prominens* Pillans

Elegia prominens occurred on the coast and coastal flats between Darling and Cape Hangklip (Fig. 1). The species was confined to level and gently sloping sites on transported sand of Tertiary to Recent origin, usually on low-lying, comparatively poorly drained ground.

The vegetation associated with *E. prominens* was a restioid-ericoid-proteoid (*sensu* Taylor, in press) Coastal Fynbos, 0,3–1,8 m high. Communities with different populations showed wide floristic variation; species recorded with three or more populations included several members of the Restionaceae (Table 2). *Elegia prominens* occurred on the coastal shelf of the southern Cape Peninsula in vegetation resembling described communities (Table 1, Appendix 1) of marshy flats as well as of better-drained loose sands (probably alkaline) on which *Thamnochortus erectus* was dominant. An erect-tufted, ''giant'' form of *E. prominens* occurred near Mamre Road and near Philadelphia in 1,6–1,8 m high vegetation similar to that in which a northern population of *Restio micans* grew (Milewski & Esterhuysen, 1977), with, e.g. *Leucadendron cinereum, Elegia parviflora, Chondropetalum nudum, C. tectorum, Berzelia abrotanoides, Erica* spp. and *Metalasia* spp.

4. *Elegia verreauxii* Mast.

Elegia verreauxii (Fig. 1) occurred between Hopefield and Cape Agulhas. The species was confined to level sites on sandy substrates, ranging from Table Mountain Sandstone-derived sand to fine-grained, pale Tertiary sand with an admixture of clay, and Tertiary ''calcified dune sand'' of the Bredasdorp beds. It occurred on the floors of broad, poorly-drained depressions, where the soil was perennially moist and seasonally waterlogged.

The vegetation associated with, and usually dominated by, *E. verreauxii* was a mainly restioid fynbos, 0,2–0,5 m high. Communities with different populations showed wide floristic variation; species recorded with two or more populations included *Gnidia viridis, Cynodon dactylon, Elegia prominens, Restio sabulosus* and several other members of the Restionaceae (Table 2). *Elegia verreauxii* occurred on the northern Cape Flats in vegetation sharing several species with communities (Appendix 1) of similar moist depressions overlying limestone and sandstone on the False Bay coast. *Arthrocnemum* sp. or spp. and *Plantago carnosa*, among these, appear indicative that *E. verreauxii* is comparatively tolerant of edaphic salinity.

5. *Restio sabulosus* Pillans

Restio sabulosus (Fig. 2) was confined to level sites on fine-grained transported sand of Tertiary to Recent origin, including "calcified dune sand" of the Bredasdorp beds. The species occurred on the floors of broad coastal depressions inland from the littoral dunes, under conditions of drainage similar to those for *Elegia verreauxii*.

The vegetation associated with *R. sabulosus* was a mainly restioid Coastal Fynbos, 0,2–0,5 m high. Communities on the Cape Flats and near Quoin Point appeared to differ floristically; species recorded with both populations included *Gnidia viridis, E. verreauxii* and several other members of the Restionaceae (Table 2). *Restio sabulosus* occurred on the northern Cape Flats in vegetation sharing several species with communities (Appendix 1) of similar moist depressions on the False Bay coast. The species was associated in both known populations with *E. verreauxii;* the habitat range of *R. sabulosus* appeared to fall within that of *E. verreauxii*, which evidently extended elsewhere on to soils with higher clay or salt content. An associate with the western population of *R. sabulosus* was the rare Cape Flats endemic *Cliffortia ericaefolia*.

6. *Restio dodii* Pillans

Restio dodii had a disjunct range (Fig. 2) on the south-western Cape coastal flats, near Cape Point (var. *dodii*) and in the Bredasdorp area (var. *purpureus* Pillans). The species was apparently confined to poorly drained sandy soil, described by Taylor (1969), derived from Table Mountain Sandstone.

The vegetation associated with *R. dodii* was a mainly restioid-ericoid, 0,6–1,2 m high fynbos intermediate in appearance between Coastal Fynbos and Mountain Fynbos (*sensu* Taylor, in press). Species recorded with two or more populations included *Cliffortia subsetacea, Helichrysum serpyllifolium, Berzelia abrotanoides, B. lanuginosa, Scyphogyne muscosa* and several members of the Restionaceae (Table 2). *Restio dodii* occurred on the coastal plateau near Cape Point in floristically well-documented marsh communities (Table 1, Appendix 1). The species grew near Pearly Beach in similar vegetation.

TABLE 1

Precipitation, altitudinal range, substrates and most-detailed mapped plant communities for sites of populations of seven study species of Restionaceae.

Study species	Average annual precipitation (mm)	Altitudinal range (m)	Substrate	Most-detailed mapped plant community	
				Name	Author
Elegia fenestrata	600–650	40–115	shallow to deep sand over Table Mountain Sandstone (possibly also over Alexandria limestone)	Dune Mixed Fynbos Association (Coast Fynbos Alliance); between Restionaceous Tussock Marsh and *Eriocephalus* Coast-shelf Fynbos (Coast Fynbos Alliance)	Taylor (1969)
Elegia prominens	550–950	6–90	deep sand over Table Mountain Sandstone, Cape Granite, and Malmesbury shale (possibly also over Alexandria limestone)	(i) between *Eriocephalus* Coast-shelf Fynbos (Coast Fynbos Alliance), Restionaceous Tussock Marsh (Inland Fynbos Alliance) and *Sideroxylon* Scrub	Taylor (1969)
				(ii) *Eriocephalus* Coast-shelf & Dune Fynbos (Coast Fynbos Alliance)	Taylor (1969)
				(iii) probably Mixed Coastal Fynbos of Acid Sands (Coastal Plain Vegetation)	Boucher (1972)
				(iv) Coastal Dune Vegetation, or *Leucadendron coniferum* Limestone Fynbos (Coastal Plain Vegetation)	Boucher (1972)

				Vegetation, or *Leucadendron coniferum* Limestone Fynbos (Coastal Plain	
Elegia verreauxii	350–900	80–90 (one herbarium specimen from 300)	shallow to deep sand over Table Mountain Sandstone, Cape Granite, Malmesbury shale	(i) Restionaceous Tussock Marsh (Inland Fynbos Alliance)	Taylor (1969)
				(ii) overall distribution of the species centred on Coastal Macchia	Acocks (1975)
Restio sabulosus	500–550	8–30	shallow to deep sand over Malmesbury shale, Table Mountain Sandstone	Coastal Macchia	Acocks (1975)
Restio dodii	see Taylor (1969)	see Taylor (1969)	very shallow to shallow, peaty sand over Table Mountain Sandstone	(i) Restionaceous Tussock Marsh, partly also in *Berzelia-Osmitopsis* Seepage Scrub (Inland Fynbos Alliance)	Taylor (1969)
				(ii) Coastal Macchia	Acocks (1975)
Thamnochortus fraternus	550–900	5–150	very shallow to shallow sand over limestone	(i) Dwarf Dune Mixed Fynbos Sub-association (Coast Fynbos Alliance)	Taylor (1969)
				(ii) *Leucadendron coniferum* Limestone Fynbos (Coastal Plain Vegetation)	Boucher (1972)
Thamnochortus pellucidus	500–900	30–100	shallow sand over Table Mountain Sandstone (possibly also over Alexandria limestone)	(i) boundary between Mixed Coastal Fynbos of Acid Sands (Coastal Plain Vegetation) and Mixed Ericoid and Restioid Fynbos of the Xeric Seaward Slopes (Coastal Mountain Fynbos)	Boucher (1972)
				(ii) overall distribution of species centred on Coastal Macchia	Acocks (1975)

TABLE 2.

Restionaceous associates, according to "between-population frequency", of seven Restionaceous study species: 1 = *Thamnochortus fraternus*, 2 = *Elegia fenestrata*, 3 = *Thamnochortus pellucidus*, 4 = *Restio sabulosus*, 5 = *Elegia verreauxii*, 6 = *Elegia prominens*, 7 = *Restio dodii*. Mean number of study plants investigated per population was (range in parentheses): 1 = 48 (35–65), 2 = 62 (50–85), 3 = 50 (40–58), 4 = 60 (50–70), 5 = 66 (50–76), 6 = 45 (35–58), 7 = 52 (22–60). Numerator equals the number of populations in which the associate species was recorded within 0,25 m of plants of the study species; denominator equals total number of investigated populations of the study species; "+" denotes that the Restionaceous associate species was present in the same stand of vegetation as the study species, but not recorded within 0,25 m.

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Restio leptocladus Mast.	1/3						
Restio eleocharis Nees ex Mast.	2/3						
Leptocarpus paniculatus (Rottb.) Mast.		1/3					
Leptocarpus asper (Mast.) Pillans			1/3				
Leptocarpus sp. nov. aff. *L. fruticosus* Mast.			1/3				
Thamnochortus guthrieae Pillans			1/3				
Leptocarpus hyalinus (Mast.) Pillans			1/3				
Restio egregius Hochst.			1/3				
Elegia stipularis Mast.			3/3				
Hypolaena digitata (Thunb.) Pillans			2/3				
Thamnochortus gracilis (Dur. & Schinz) Mast.			2/3				
Staberoha multispicula Pillans			2/3				
Leptocarpus vimineus (Rottb.) Pillans				1/2	1/3		
Elegia prominens Pillans (including giant form)				+	2/3		
Thamnochortus obtusus Pillans				+	+		
Chondropetalum rectum (Mast.) Pillans					1/3		
Restio sp. nov. aff. *R. tenuissimus* Kunth					1/3	+	
Restio sabulosus Pillans					2/3	+	
Restio macer Kunth					1/3	1/5	
Thamnochortus punctatus Pillans						+	
Leptocarpus impolitus (Kunth) Pillans						+	
Restio micans (Kunth) Nees						+	
Willdenowia arescens Kunth						1/5	
Hypodiscus willdenowia (Nees) Mast.						2/5	

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Willdenowia sulcata Mast.						2/5	
Restio cincinnatus Mast.						+	+
Restio paludosus Pillans						1/5	2/3
Restio quinquefarius Nees						1/5	2/3
Restio bifurcus Nees ex Mast.						2/5	2/3
Elegia asperiflora (Nees) Kunth							+
Elegia thyrsifera (Rottb.) Pers.							+
Willdenowia humilis Mast.							+
Hypolaena sp. indet.							1/3
Restio pedicellatus Mast.							1/3
Restio bifidus Thunb.							1/3
Elegia cuspidata Mast.							2/3
Leptocarpus fruticosus Mast.	3/3	2/3	1/3				
Willdenowia teres Thunb.	2/3	1/3	2/3				
Chondropetalum microcarpum (Kunth) Pillans	1/3	1/3		1/2	1/3	2/5	
Thamnochortus fruticosus Berg.	1/3			+	+	1/5	
Thamnochortus erectus Thunb. (Mast.)	1/3					2/5	
Chondropetalum tectorum (L.) Pillans (including small form)		3/3		1/2	1/3	2/5	
Elegia verreauxii Mast.				2/2		2/5	
Restio sp. or spp. aff. *R. tenuissimus* Kunth			3/3	1/2	1/3	1/5	
Restio cuspidatus Thunb.			3/3	+	+	2/5	
Restio triticeus Rottb.		1/3	1/3	2/2	3/3	3/5	
Chondropetalum nudum (Nees) Rottb.		1/3	1/3	2/2	3/3	4/5	2/3
Elegia fistulosa Kunth		1/3					+
Restio compressus Rottb.		1/3					3/3
Elegia parviflora Kunth (including several forms)			3/3	1/2	2/3	3/5	3/3
Elegia neesii (Mast.) Mast.			1/3			1/5	2/3
Staberoha distachya (Rottb.) Kunth*			+			+	+
Staberoha cernua (L.f.) Dur. & Schinz			1/3				2/3
Hypodiscus aristatus (Thunb.) Nees			2/3				+
Elegia vaginulata Mast.				+	+		1/3

*Note that in some cases it was impossible to distinguish between *S. distachya* and *S. cernua*.

7. *Thamnochortus fraternus* Pillans

Thamnochortus fraternus (Fig. 2) was evidently confined to well-drained, lime-rich coastal deposits of Tertiary to Recent transported origin between Cape Point and Cape Agulhas. It occurred on substrates ranging from small pockets of soil (''Mispah'' form, ''Muden'' series) on outcrops of limestone, to sand apparently more than 1 m deep overlying limestone or sandstone. The species was found, for example, near Cape Point on the level surface limestone, and derived fine-grained soil, of a calcified dune overlying a Table Mountain Sandstone plateau, at Hangklip on calcified aeolian sand piled steeply against seaward Table Mountain Sandstone slopes, and at Pearly Beach on the steep hill slopes of exposed limestone of the Alexandria beds.

The 0,4–2,0 m high vegetation associated with *T. fraternus* ranged from proteoid-ericoid-restioid Coastal Fynbos to communities transitional between fynbos and broad-leaved littoral dune scrub (''strandveld'' *sensu* Taylor, in press). Species recorded with two or more populations included *Asparagus stipulaceus, Myrica quercifolia, Senecio arnicaeflorus, Passerina paleacea, Rhus glauca, Euclea racemosa, Lightfootia tenella, Carpobrotus acinaciformis, Erica coccinea, Knowltonia capensis, Pelargonium betulinum, Limonium scabrum* and several members of the Restionaceae (Table 2).

The set of plant species collectively associated with *T. fraternus* had much in common (Appendix 1) with lists representing fynbos on calcified dunes on the False Bay coast, vegetation partly ''of transitional nature with elements of dune scrub'' (Boucher, 1972). *Thamnochortus fraternus* has, for example, previously been found to be confined to a fynbos community restricted in the Cape of Good Hope Nature Reserve to calcified dunes, and containing ''many plants absent or rare elsewhere in the Reserve'' (Taylor, 1969). A population of *T. fraternus* near Hangklip, by contrast, shared more associates with broad-leaved littoral dune scrub than it did with fynbos on calcified dunes. *Carpobrotus acinaciformis, Restio eleocharis, Psoralea fruticans, Passerina paleacea, Myrica cordifolia* and *Metalasia muricata* were, for example, among the characteristic species for Boucher's (1972) *Colpoon-Rhus* Dune Scrub, whereas only *Metalasia muricata* and *Senecio arnicaeflorus* were among his characteristic species for *Leucadendron coniferum* Limestone Fynbos.

8. *Thamnochortus pellucidus* Pillans

Thamnochortus pellucidus occurred on the coast between Cape Hangklip and Cape Agulhas (Fig. 2). The species was confined to gently sloping sites on pale transported sandy soil of Table Mountain Sandstone or Tertiary origin, apparently including ''calcified dune sand'' of the Bredasdorp beds. Most known populations were on the coastal shelf between the littoral dunes and cliffs and the first inland hill-slopes. The species was found, for example, near Brandfontein (Bredasdorp coast) at the base of seaward Table Mountain Sandstone slopes and near Klein-

TABLE 3

Proteaceous associates, according to collective presence and absence, of seven Restionaceous study species: 1 = *Thamnochortus fraternus*, 2 = *Elegia fenestrata*, 3 = *Thamnochortus pellucidus*, 4 = *Restio sabulosus*, 5 = *Elegia verreauxii*, 6 = *Elegia prominens*, 7 = *Restio dodii* (sample sizes as for Table 2). "×" denotes that the Proteaceous associate species was recorded within 0,25 m of a plant of the study species; "+" denotes that the species was present in the same stand of vegetation as the study species, but not recorded within 0,25 m.

Associate species	Occurrence with study species						
	1	2	3	4	5	6	7
Leucadendron meridianum Williams	×						
Protea obtusifolia Buek.	×						
Leucospermum patersonii Phillips	×						
Mimetes saxatilis Phill.	×						
Leucospermum pedunculatum Klatzsch in Krauss		×	×				
Mimetes cucullata (L.) R.Br.		×	×				
Leucospermum hypophyllocarpodendron (L.) Druce ssp. *hypophyllocarpodendron*		+	×			+	
Protea subulifolia (Salisb. ex Knight) Rourke			×				
Protea susannae Phillips			×				
Serruria nervosa Meisn.			×				
Leucospermum pedunculatum × *hypophyllocarpodendron* (hybrid)			×				
Spatalla ericoides Phillips			×				
Aulax umbellata (Thunb.) R. Br.			×				
Serruria adscendens R. Br.			×				
Serruria bolusii Phill. & Hutch.			×				
Leucadendron levisanus (L.) Berg.				×	×	+	
Leucadendron corymbosum Berg.					×		
Leucadendron cinereum (Solander ex Ait.) R. Br.					×	×	
Serruria decipiens R. Br.					+	×	
Leucospermum hypophyllocarpodendron (L.) Druce ssp. *canaliculatum* (Buek ex Meisn.) Rourke						+	
Protea scolymocephala Reich.						+	
Diastella proteoides (L.) Druce						×	
Diastella divaricata (Berg.) Rourke						×	+
Serruria glomerata R. Br.						×	×
Leucadendron laureolum (Lam.) Fourcade							×
Leucadendron floridum R. Br.							×
Protea cynaroides L.							+
Leucadendron coniferum (L.) Meisn.	×	×	+			+	
Leucadendron xanthoconus (O. Ktze.) K. Schum.		×	×				×
Leucadendron salignum Berg.			×			×	
Leucadendron linifolium (Jacq.) R. Br.			×	×	×		
Serruria ciliata R. Br.				×	×	×	

TABLE 4

Percentage similarity between sets of associates for seven study species of Restionaceae, using "between-population frequency" data on Restionaceous associates (Table 2) to calculate the Czekanowski coefficient. The formula used was $\frac{2w}{A+B} \times 100$ (Bray & Curtis, 1957), where w = number of associate species in common, A = number of associates for one study species, and B = number of associates for another study species. Values in parentheses are percentage similarity between sets of Restionaceous and Proteaceous associates for congeneric pairs of study species (collective presence and absence data only on all associates, Tables 2 & 3, for each study species were used). "+" data in Tables 2 and 3 were ignored.

	Study species						
	1	2	3	4	5	6	7
1. *Thamnochortus fraternus*		34,8	13,9 (8,9)	3,3	6,1	3,6	0
2. *Elegia fenestrata*			18,2	12,7	23,5 (25,8)	5,7 (20,5)	11,1
3. *Thamnochortus pellucidus*				7,8	18,5	6,6	21,4
4. *Restio sabulosus*					31,3	14,2	6,9 (13,8)
5. *Elegia verreauxii*						14,3 (50,0)	17,4
6. *Elegia prominens*							8,5
7. *Restio dodii*							

mond on a sandy bank lining a perennial stream farther inland in similar country; peripheral hill-slopes near Quoin Point were, by contrast, of Alexandria limestone.

The vegetation associated with *T. pellucidus* was a mainly restioid-ericoid fynbos, 0,5–0,8 m high. Species recorded with two or more populations included *Erica imbricata, E. pulchella, Mimetes cucullata, Leucospermum pedunculatum, L. hypophyllocarpodendron, Helichrysum sesamoides, Phaenocoma prolifera, Staavia radiata, Penaea mucronata, Aspalathus callosa* and several members of the Restionaceae (Table 2). The set of plant species collectively associated with *T. pellucidus* had much in common with a list representing a previously described community on acidic soil of "Fernwood" form and "sandveld" series (Appendix 1). A population of *T. pellucidus* near Kleinmond was sited marginally (Table 1) to the area mapped by Boucher (1972) for this community.

9. *Comparison of habitats of congeneric study species*

Table 4 shows percentage similarity between sets of Restionaceous associate species for the study species, calculated using information on the differences between populations ("between-population frequency"). Similarity values were generally low; the only pairs of species for which there was more than 30% similarity between sets of associates were *Restio sabulosus* with *Elegia verreauxii*, and *Thamnochortus fraternus* with *Elegia fenestrata.* The only pair of congeneric species showing more than 20% similarity was *E. fenestrata* with *E. verreauxii;* however, *E. prominens* showed 50% similarity with *E. verreauxii* at a coarser level, i.e. according to collective presence and absence of both Restionaceous and Proteaceous associates.

This numerical assessment of similarities can be viewed as a preliminary measure of habitat similarity for the study species. However, such an interpretation assumes that qualitative floristic data, restricted to two sample families, convey an adequate and valid reflection of the range of environmental conditions under which the study species grow.

Elegia fenestrata, E. prominens and *E. verreauxii* are partly sympatric (*sensu* Davis & Heywood, 1967) and show some habitat overlap; *E. prominens* and *E. verreauxii* occur together as associates in certain areas. All three species appear restricted to relatively poorly drained sandy soils, *E. fenestrata* evidently occurring on permanently waterlogged, *E. verreauxii* (with *Restio sabulosus*) on seasonally waterlogged, and *E. prominens* on seasonally moist to waterlogged ground. The habitat range of *E. prominens* appears akin to but wider than that of sympatric *Restio micans*, a species of more restricted occurrence (Milewski & Esterhuysen, 1977).

The two study species of *Restio* are partly sympatric and appear both to occupy seasonally waterlogged flats environments. Their habitats are, however, evidently distinct, *R. sabulosus* growing on littoral sand and *R. dodii* on the sandstone coastal plateau.

Thamnochortus fraternus and *T. pellucidus*, both growing on well-drained flats and slopes of the coastal shelf and adjacent hills, are largely sympatric. Their habitats are, however, quite different; *T. fraternus* grows mainly on limestone- and *T. pellucidus* mainly on sandstone-derived substrates.

CONCLUSIONS

Elegia verreauxii, *Restio dodii* and *Thamnochortus pellucidus*, growing partly on Table Mountain Sandstone-derived soil on coastal uplands, occur in communities marginal to the Mountain Fynbos (*sensu* Taylor, in press) biotope. The habitats of all the study species can nevertheless be considered to fall within that of Coastal Fynbos, a heterogeneous (Acocks, 1975), little-studied and poorly defined biotope.

Weimarck (1941), referring to the pronounced floristic endemism in Mountain Fynbos on peaks of the sandstone Cape mountain ranges, stated that endemism on the coastal flats was virtually restricted to "ecologically unique" areas, mainly limestone environments. He regarded the western flats, and the southern flats between Bredasdorp, Riviersonderend and Breede River mouth, to be very poor in endemics relative to the limestone flats, west of Bredasdorp and near Riversdale. Several other workers (Muir, 1929; Taylor, 1969, 1972; Rourke, 1972; Acocks, 1975) have also alluded to the apparent floristic distinctiveness of Coastal Fynbos on calcified substrates. *Leucadendron meridianum* (one of only two members of its genus growing with their root systems intimately associated with parent limestone) is, for example, regarded as "calciphilous", as are *Mimetes saxatilis*, *Protea obtusifolia* and *Leucospermum patersonii* (Williams, 1972; Rourke, 1972). *Thamnochortus fraternus* is an associate of these members of the Proteaceae and shows little habitat similarity with the other study species; it thus appears to be another species contributing to the floristic distinctiveness of fynbos on limestone. The "ecological uniqueness" of the environments of the other study species appears mainly owing to particular drainage conditions, supplemented by other edaphic factors.

These findings have a bearing on the conservation of coastal flats endemics. All the study species except *T. pellucidus* and *R. sabulosus* occur in an established conservation area, the Cape of Good Hope Nature Reserve. However, the area of limestone and coastal sand in this reserve is limited, and remaining flats environments are rapidly deteriorating, owing chiefly to encroachment of alien *Acacia* species and intensive development for farming and housing. The establishment of a network of edaphically diverse coastal reserves, although long overdue, would greatly improve the prospects for conservation of the full range of Coastal Fynbos species and ecosystems.

APPENDIX 1

Described plant communities showing floristic similarity to collective sets of associates for each study species of Restionaceae

Study species	Plant community		Examples of species in common
	Name	Author	
Elegia fenestrata	*Helichrysum-Scirpus* Marsh Association (Coast Fynbos Alliance)	Taylor (1969)	*Schoenus nigricans*, *Carex clavata*, *Merxmuellera cincta*, *Juncus kraussii*, *Chondropetalum tectorum*, *C. nudum*, *Pelargonium grossularioides*, *Cliffortia ferruginea*, *Myrica quercifolia*, *Helichrysum serpyllifolium*, *Othonna quinquedentata*, *Senecio halimifolius* and *Samolus valerandi*
	and *Senecio halimifolius-Scirpus nodosus*, and *Myrica quercifolia-Zygophyllum fulvum* communities	Milton (unpub.)	
	Inland Dune Fynbos Subassociation	Taylor (1969)	*Leucadendron coniferum*, *Willdenowia teres* *Chondropetalum microcarpum*, *Erica coarctata*
	and *Leucadendron coniferum* Limestone Fynbos	Boucher (1972)	
	and *Willdenowia teres*, *Ehrharta villosa*, *Erica coarctata*, and *Cliffortia falcata-Chondropetalum microcarpum* communities	Milton (unpub.)	
	Berzelia-Osmitopsis Seepage Scrub Association	Taylor (1969)	*Berzelia lanuginosa*
	and *Brunia-Erica* Seepage Fynbos	Boucher (1972)	
Elegia prominens	Restionaceous Tussock Marsh Association; Dune Fynbos Association	Taylor (1969)	*Elegia parviflora*, *Chondropetalum nudum*, *Restio quinquefarius*, *R. bifurcus*, *Pentaschistis curvifolia*, *Scyphogyne muscosa*, *Struthiola ciliata*, *Cliffortia subsetacea*, *Serruria glomerata* and *Diastella divaricata*; *Thamnochortus erectus*, *Phylica stipularis*, *Cliffortia falcata*, *C. filifolia* and *Diosma hirsuta*
Elegia verreauxii and *Restio sabulosus*	*Helichrysum-Scirpus* Marsh Association	Taylor (1969)	*Helichrysum serpyllifolium*, *Metalasia muricata*, *Orpheum frutescens*, *Aspalathus hispida*, *Schoenus nigricans*, *Chondropetalum tectorum* and *C. nudum*
	and *Myrica quercifolia-Zygophyllum fulvum* community	Milton (unpub.)	

Study species	Plant community		Examples of species in common
	Name	Author	
Thamnochortus fraternus	1. Fynbos communities: Dwarf Dune Mixed Fynbos Sub-association*	Taylor (1969)	**T. fraternus* is a conspicuous character species for this community (floristic details available in Taylor's thesis) *Erica coarctata, Cliffortia falcata, Disparago anomala, Metalasia brevifolia, Diosma hirsuta, Aspalathus forbesii, Myrica quercifolia, Struthiola salteri, Olea capensis, Asparagus stipulaceus, Chascanum cernuum, Erica coccinea, Leucadendron coniferum, Chondropetalum microcarpum* and *Thamnochortus erectus*
	Inland Dune Fynbos Sub-association	Taylor (1969)	
	and *Leucadendron coniferum* Limestone Fynbos	Boucher (1972)	
	and *Erica coarctata, Cliffortia falcata-Chondropetalum microcarpum*, and *Myrica quercifolia-Zygophyllum fulvum* communities	Milton (unpub.)	
	2. Broad-leaved littoral dune scrub communities: Coast Scrub Association, including Littoral Dune Mixed Fynbos Sub-association (on "Fernwood" sand)	Taylor (1969)	*Myrica cordifolia, Metalasia muricata, Restio eleocharis, Euclea racemosa, Passerina paleacea, Rhus glauca, Psoralea fruticans, Carpobrotus acinaciformis*
	and Coastal Dune Broad-leaved Scrub: *Arctotheca-Myrica* Strand Pioneers, and *Colpoon-Rhus* Dune Scrub	Boucher (1972)	
	and *Myrica cordifolia, Metalasia muricata-Passerina paleacea, Euclea racemosa*, and *Pterocelastrus* communities	Milton (unpub.)	
Thamnochortus pellucidus	Mixed Ericoid and Restioid Fynbos of the Xeric Seaward Slopes	Boucher (1972)	*Elegia parviflora, Staberoha cernua, Restio egregius, R. cuspidatus, Leptocarpus hyalinus, Hypodiscus aristatus, Agathelpis dubia, Gnidia pinifolia, Phaenocoma prolifera, Helichrysum sesamoides, Serruria adscendens*, and *Aspalathus aspalathoides* (the last species being recorded only from this community by Boucher)
Restio dodii	mainly Restionaceous Tussock Marsh Association, also *Berzelia-Osmitopsis* Seepage		floristic details of plots in which *R. dodii* occurred are available in Taylor's thesis (*R. dodii* var. *dodii* is restricted to the Cape of Good Hope Nature Reserve)

ACKNOWLEDGEMENTS

I wish to thank Professor E. A. C. L. E. Schelpe for the use of facilities at the Bolus Herbarium, University of Cape Town. Dr A. V. Hall, project leader of the Rare and Endangered Plant Species Research Group, supervised the study. Miss E. Esterhuysen, Dr J. P. Rourke and Mr H. F. Glen assisted with identification of Restionaceae, Proteaceae and Mesembryanthemaceae respectively. Dr E. J. Moll commented on the manuscript. Miss S. J. Milton kindly made unpublished information available to me. An initial herbarium survey for endemic species was undertaken by Mrs M. Bates, Miss G. M. van Niekerk and Miss G. M. Micklem. Financial assistance provided under the National Programme for Environmental Sciences is gratefully acknowledged. I am indebted to Mrs M. L. Jarman and Miss C. Davidge for typing the manuscript.

REFERENCES

ACOCKS, J. P. H., 1975. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* **40.**

BOUCHER, C., 1972. *The vegetation of the Cape Hangklip Area.* M.Sc. thesis. Cape Town: University of Cape Town.

BOUCHER, C. and JARMAN, M. L., 1977. The vegetation of the Langebaan area. *Trans. R. Soc. S. Afr.* **42:** 241–272.

BRAY, R. J. and CURTIS, T. T., 1957. An ordination of upland forest communities of southern Wisconsin. *Ecol. Monogr.* **22:** 325–349.

DAVIS, P. H. and HEYWOOD, V. H., 1967. Principles of Angiosperm taxonomy. Edinburgh & London: Oliver & Boyd.

MILEWSKI, A. V. and ESTERHUYSEN, E., 1977. Habitat of Restionaceae endemic to western Cape coastal flats. *Jl S. Afr. Bot.* **43:** 233–241.

MILTON, S. J., unpublished. *A phytosociological survey of dunelands of False Bay coast.* Cape Town: Botany Department, University of Cape Town, 1976.

MUIR, J., 1929. The vegetation of the Riversdale area, Cape Province. *Mem. bot. Surv. S. Afr.* **13.**

RARE AND ENDANGERED SPECIES RESEARCH GROUP. Unpublished reports on threatened plant taxa in the south-western Cape. Cape Town: Bolus Herbarium, 1976.

ROURKE, J. P., 1972. Taxonomic studies on *Leucospermum* R. Br. *Jl S. Afr. Bot.* Suppl. vol. **8.**

TAYLOR, H. C., 1969. *Vegetation of the Cape of Good Hope Nature Reserve.* M.Sc. thesis. Cape Town: University of Cape Town.

TAYLOR, H. C., 1972. Notes on the vegetation of the Cape Flats. *Bothalia* **10**(4): 637–646.

TAYLOR, H. C., in press. Phytogeography and ecology of Capensis. In: M. J. A. Werger, (ed.), *Biogeography and ecology of Southern Africa.* The Hague: Junk.

WEIMARCK, H., 1941. Phytogeographical groups, centres and intervals within the Cape flora. *Acta Univ. lund.* N.F. Avd. **2,** 37(5).

WILLIAMS, I. J. M., 1972. A revision of the genus *Leucadendron* (Proteaceae). *Contr. Bol. Herb.* **3.**